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Chemical Kinetics in the C-O-S and H-N-O-S Systems:

A Bibliography— 1899 through June 1971

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Francis Westley

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FOREWORD

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The task of critical evaluation is carried out in various data centers, each with a well-defined technical scope. A necessary preliminary step to the critical evaluation process is the retrieval from the world scientific literature of all papers falling within the scope of the center. Each center, therefore, builds up a comprehensive well-indexed bibliographical file which forms the base for the evaluation task. Since these bibliographical records are potentially of value to many research workers and others interested in the particular technical area, it seems desirable to make them generally available.

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David R. Lide, Jr.,
Chief, Office of Standard
Reference Data

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CHEMICAL KINETICS IN THE C-O-S AND H-N-O-S SYSTEMS:

A BIBLIOGRAPHY - 1899 through June 1971‡

FRANCIS WESTLEY

A bibliography, a reaction oriented list of references, is provided for published papers and reports containing rate data for reactions of COS, COS_2, CS, CS_2, CS_3, D_2S, H_2S, H_2S_2, HSO_2, S, SH, SO, SO_2, SO_3, SO_4, S_2, S_2O_2, S_4, S_6 and S_8 with each other and with CO, CO_2, D, D_2, H, H_2, H_2O, N, N_2, N_2O, N_2O_5, NO, NO_2, NO_3, NOS, O, OH, O_2, O_3, R and RH. Three lists of critical reviews dealing with the above reactions are included. 317 papers covering 240 reactions are listed. The period covered extends from 1899 through June 1971.

Key words: Bibliography; carbon oxysulfides; carbon sulfides; chemical kinetics; gas phase; hydrogen; nitrogen; nitrogen oxides; oxygen; sulfur; sulfur hydrides; sulfur oxides.

Introduction

This bibliography lists papers and reports on the gas phase reaction kinetics in the carbon - oxygen - sulfur, carbon - sulfur, and hydrogen - nitrogen - oxygen - sulfur systems. The material is presented in two ways: (1) by reaction, listing each pertinent article and (2) in a general reference list, arranged alphabetically by first author.

The articles have been selected from the files of the Chemical Kinetics Information Center. The criterion for inclusion of an article is that there must be some new information on the reaction, when the article in question is compared with the chronologically preceding ones. That is, simple quotations of the results of others and ad hoc guesses have been excluded. There are gray areas, such as the statement of a rate calculated from that of the reverse reaction and the equilibrium constant, or mechanistic information. If the information seemed to be important the reference was included.

Most of the reactions listed in this bibliography show a chemical change. Some of these show a photolytic, chemiluminescent or energy transfer process that occurs simultaneously

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‡ This project is an activity of the Chemical Kinetics Information Center, N.B.S. The work was supported by the Office of Standard Reference Data, N.B.S., and the Naval Ordnance Systems Command ORD 3311 as part of a program to foster the production of tables of chemical kinetics.

with chemical change. In addition there are a few reactions that are simply collisional energy transfer or photo excitation processes.

Symbols defining specific electronic or vibronic states are not used. Instead an excited atom or molecule is indicated by a simple asterisk. The nature of a collisional process is indicated in an explanatory parenthesis following the reaction.

Some of these reactions have been studied since the early days of chemical kinetics. For instance, the reaction for the H_2S synthesis from its elements:

$$H_2 + S\ (+ M) \rightarrow H_2S\ (+ M) \qquad (1)$$

was studied kinetically for the first time by Bodenstein[5]*, just before the end of 19th century. Its study was continued in the nineteen twenties by Norrish and Rideal[20, 21, 23] and in the thirties by Aynsley[1, 2, 3]. The oxidation of H_2S by molecular oxygen

$$H_2S + 3/2O_2 \rightarrow H_2O + SO_2 \qquad (2)$$

was studied for the first time in 1928 by Chamberlin and Clarke[6] who measured the flame velocities of this reaction. The first rate studies were undertaken by Farkas[10] in 1931 and - at about the same time - by Taylor and Livingston[32], Thompson[33] and Kelland[34]. The synthesis of SO_2 from its elements

$$O_2 + S(+ M) \rightarrow SO_2(+ M) \qquad (3)$$

was studied by Norrish and Rideal[21, 22] in 1923. Gaydon[11], in 1934, offered a mechanism for the fluorescence of heated SO_2:

$$SO_2\ (+ M) \rightarrow O + SO\ (+ M) \qquad (4)$$

$$O + SO \rightarrow SO_2 + h\nu \qquad (5)$$

The photokinetics of sulfur oxides is a few decades older than the Gaydon mechanism. For instance, in 1907, Coehn[7] and a few years later Coehn and Becker[8] studied the photooxidation of SO_2 by molecular oxygen, as well as the photodissociation of SO_3 to O_2 and SO_2:

$$1/2O_2 + SO_2 + h\nu \rightarrow SO_3 \qquad (6)$$

$$SO_3 + h\nu \rightarrow 1/2O_2 + SO_2 \qquad (7)$$

Studies of the kinetics of carbon sulfides and carbon oxysulfides are relatively recent, the ground work in this field being laid down by Kondrat'ev[17, 18, 19] and Jakovleva[16] in 1938 and 1940.

In the field of energy transfer reactions, the first study for the vibrational relaxation of an excited SO_2 molecule was performed by Schweikert[29] in 1915, by using sound absorption techniques. Major advances in understanding the kinetics and mechanism of fluorescence and quenching of the electronically excited SO_2 molecule were made by

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* Superscript figures indicate the literature references listed at the end of the introduction

Halstead[12, 13, 14], Thrush[35] and Calvert and coworkers[4, 9, 15, 24, 25, 26, 27, 28, 30, 31].

This short historical survey of the gas phase reaction kinetics in the hydrogen - oxygen - sulfur system, extending from the beginning of the century until today, allows a comparison with kinetic history of nitrogen - oxygen system for the same period of time. As pointed out in a previous N - O chemical kinetics bibliography[37], the experimental work on the nitrogen - oxygen system started at the beginning of this century and - since then - has been continuing uninterrupted. The abundance of experimental kinetic studies for this system is such that many chemists have undertaken reanalyses of the existing data with the goal of establishing "best values". The number of critical reviews for the kinetics of the N - O system is impressive. Moreover, the molecular structure of these molecules has been established and their electronic and vibrational spectra analyzed (with the important exception of the visible bands of NO_2). These structural and kinetic data make it possible to answer, quantitatively, questions about the behavior of these molecules in a polluted atmosphere.

Turning now to the hydrogen - nitrogen - oxygen - sulfur system, the picture is completely different: the number of papers dealing with the kinetics of this set, from the beginning of the century until today, is about one third of the corresponding number of papers in the N - O system, in spite of the fact that the number of reactions studied in the sulfur set is almost equal to the number of reactions in the nitrogen - oxygen system. The uncertainty of the existing kinetic data in the H - N - O - S system is such that few attempts have been made to establish best values for the rates. The number of critical reviews is disappointingly small. Furthermore, the interpretation of spectral data is not nearly so complete as for the nitrogen oxides.

The state of the matter has been very well described in a paper by Urone and Schroeder[36] entitled: "SO_2 in the atmosphere: a wealth of monitoring data, but few reaction rate studies." The conclusion of these authors is valid for the whole H - N - O - S system. It is only too obvious that sulfur, together with its inorganic and organic compounds, should be at least as important for the pollution scientist as the simpler N - O ststem. Indeed, sulfur, or its compounds, is not a component of the "pure" air, but a villain, and - maybe - one of the greatest villains. Sulfur and its compounds are present in volcanic emissions and in fuel combustion products as rubber and tires, automobile exhausts, industrial wastes, synthetic fibers, and so on. And, from these sources, it goes into the atmosphere, in one form or another, polluting it.

For these reasons, the editor hopes that this bibliography by summing up what has been done in the field of chemical kinetics of the H - N - O - S system, will make it possible to establish - by difference - what remains to be done in this field. Should this be done, it would allow the kineticists, the spectroscopists and the quantum chemists to plan a concerted, more thorough study of this system.

This bibliography is not the result of the effort of a single person, but of the whole staff of Chemical Kinetics Information Center. My thanks to all of them.

In particular, I wish to thank Dr. David Garvin, Director of the Center, for his more than helpful suggestions and constant guidance; Mr. James G. Koch, Supervisor, for tracking down and obtaining papers and reports, otherwise very difficult to obtain; Mrs. Ann C. Robertson and Mrs. Geraldine W. Zumwalt, for typing a difficult manuscript with particular care.

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GUIDELINES FØR THE USER

The goal of this bibliography is to survey the chemical reactions in the C - Ø - S, C - S and H - N - Ø - S systems. Energy transfer and photo-excitation processes are included only when they appear (to us or to the original author) to be important in the mechanisms of chemical processes. The bibliography lists references to published papers and reports in which rate data are reported for reactions of CØS, $CØS_2$, CS, CS_2, CS_3, D_2S, H_2S, H_2S_2, $HSØ_2$, S, SH, SØ, $SØ_2$, $SØ_3$, $SØ_4$, S_2, $S_2Ø_2$, S_4, S_6 and S_8 with each other and with CØ, $CØ_2$, D, D_2 H, H_2, $H_2Ø$, N, N_2, $N_2Ø$, $N_2Ø_5$, NØ, $NØ_2$, $NØ_3$, NØS, Ø, ØH, $Ø_2$, $Ø_3$, R and RH. Among these compounds, nine of them include atoms arranged in a sequence other than alphabetical, namely:

HSØ, ØH, RH, SH, SØ, $SØ_2$, $SØ_3$, $SØ_4$, $S_2Ø_2$

The sequence of atoms in each of these compounds is based on traditional convention. As written above, all three sequences of atoms, free radicals and molecules define the order in which the reactions are arranged, i.e.: semi-alphabetically by first reactant.

The rule for writing the chemical equations dealing with the above listed compounds is very simple. Within each reaction the reactants and products are arranged according to the same scheme: separately and alphabetically. The general "third body", M, is always last. This rule would be best defined by some illustrative examples.

So, one should write:

$$Ø + SØ + M \rightarrow SØ_2 + M \quad \text{and not} \quad M + SØ + Ø \rightarrow M + SØ_2$$

or: $$Ø + SH \rightarrow H + SØ \quad \text{and not} \quad HS + Ø \rightarrow SØ + H$$

or: $$NØ_2 + SØ \rightarrow NØ + SØ_2 \quad \text{and not} \quad SØ + NØ_2 \rightarrow SØ_2 + NØ$$

This ordering scheme runs counter to chemical conventions that order by oxidation state. It does bring the atom and its parent molecule together for this simple collection. The rule for arrangement is also simple. It is a character by character comparison, with the priority order being blank, numerals, and then letters. Chemical symbols without asterisk (ground state) take precedence over those with asterisk (excited state)

Example: $$Ø + SØ + M \rightarrow SØ_2 + M$$

$$Ø + SØ + M \rightarrow SØ_2^* + M$$

$$Ø + SØ + M \rightarrow SØ_2^* + M^*$$

The bibliography is in four parts:

Part I. Reactions of Carbon Øxysulfides,

Part II. Reactions of Carbon Sulfides and

Part III. Reactions of Sulfur, Sulfur Hydrides and Sulfur Øxides.

Part-IV. Is the combined bibliography for Parts I, II and III, arranged alphabetically by authors. The complete reference citation for each article mentioned is given here. Øccasionally explanatory notes are appended. These establish

the "bibliography chain" for closely related papers by the same authors.

Parts I to III are arranged by reaction, following the order indicated above. Forward and reverse reactions are listed separately. Reactants are always on the left.

At the end of these parts, the sections I(b), II(b), and III(b) each include a short list of critical reviews or surveys dealing with the reactions listed in sections I(a), II(a), and III(a), respectively.

Most of the reactions listed in parts I, II and III show a chemical change. Some of these show a photolytic, chemiluminescent or energy transfer process that occurs simultaneously with chemical change. In addition there are a few reactions that are simply collisional energy transfer or photo-excitation processes.

Symbols defining specific electronic or vibronic states are not used. Instead, an excited atom or molecule is indicated by a simple asterisk. The nature of a collisional process is indicated in our explanatory parenthesis following the reaction e.g.:

$CO S^* + M \rightarrow CO S + M$ (vibrational relaxation)

$SO^* + M \rightarrow SO + M^*$ (energy transfer)

$H_2S^* + M \rightarrow H_2S + M$ (rotational relaxation)

$SO_2^* + M \rightarrow SO_2 + M$ (electronic relaxation)

The chemical equations of the overall reactions are not always balanced. An unbalanced equation indicates that the author mentions the reactants and the products of the reaction without the help of an equation, or that the chemical equation given by the author is unbalanced.

Very often, a reference mentioning a reaction without a third body, M, will be found under a heading indicating the same reaction with M on both sides.

In order to render the chemical change occuring in a reaction easily observable to the eye, a reactant, or a product may appear two, or even three times in the same heading (e.g.: $SH + SH \rightarrow H_2S + S$, $SO + SO_3 \rightarrow SO_2 + SO_2$, $S_2O_2 + h\nu \rightarrow SO + SO$).

It is felt that the most profitable method for finding references dealing with a certain reaction included in this bibliography would be to consider first all headings with the same reactants, with or without third body M, with or without $h\nu$, in excited or ground state, and regardless of the products. Only thereafter should the user accept or reject a paper, according to his own objective. As an example: Decomposition of SO_2. The user should consider the reactions having on the left side:

$SO_2^* \rightarrow$; $SO_2 + h\nu \rightarrow$; $SO_2 + M \rightarrow$; $SO_2 + M^* \rightarrow$; $SO_2^* + M \rightarrow$; $SO_2 + SO_2^* \rightarrow$.

The references under each reaction list the author(s) and the sources, in the following form:

Author(s)	Source-Year-Volume-Page	Number of Author(s)
Thompson, H. W.	NATUA-1931-127-629	1
Halstead and Thrush	PRLAA-1966-295-380	2
Collier, et al.	JACSA-1970-92-217	3 or more

The sources are indicated by their ASTM CØDEN abbreviations*). A guide to these codes follows. A code prefixed with an asterisk is a code not in the ASTM CØDEN set. These are codes we have assigned for reports from industrial laboratories, research institutes and universitites. When the CØDEN system adopts appropriate codes they will be replaced. The present, temporary codes usually end with Z or U. They are at times derived from the company name and at times from their stock symbols.

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JOURNAL AND REPORT CODES

AANLA	Atti della Accademia Nazionale dei Lincei, Rendiconti Classe di Scienze Fisiche, Matematiche e Naturali (Rome)
ACPYA	Acta Physicochimica U.R.S.S. (Moscow)
ACSRA	Abstracts of Papers. American Chemical Society (Washington)
ACUSA	Acustica (Stuttgart/Zurich)
ADPCA	Advances in Photochemistry (London/New York)
AJCHA	Australian Journal of Chemistry (East Melbourne)
ANPYA	Annalen Der Physik (Leipzig)
*APCPZ	Air Pollution Control Association Preprints
APPLA	Applied Physics Letters (New York)
ARPLA	Annual Review of Physical Chemistry (Stanford, Calif.
ATENB	Atmospheric Environment. An International Journal (Oxford)
*AVEVZ	AVCO - Everett Research Report
AWPOA	Air and Water Pollution (Oxford)
BBPCA	Berichte Der Bunsengesellschaft Fuer Physikalische Chemie (Weinheim, Germany)
BOOKA	Book
BSCBA	Societes Chimiques Belges, Bulletin (Brussels)
CBFMA	Combustion and Flame (London)
CCOMA	Chemical Communications (London)
CHMBA	Chemistry in Britain (London)
CHPLB	Chemical Physics Letters (Amsterdam)
CJCHA	Canadian Journal of Chemistry (Ottawa)
CRAUA	Comptes Rendus (Doklady) De L'Academie Des Sciences De L'U.R.S.S (Moscow)
CSAAA	Chemical Society, Annual Reports on the Progress of Chemistry, Section A. General, Physical, and Inorganic Chemistry (London)
DABBB	Dissertation Abstracts International B. The Sciences and Engineering
DABSA	Dissertation Abstracts B. Sciences and Engineering
DFSOA	Discussions of the Faraday Society (Aberdeen, Scotland)
DKPCA	Doklady Physical Chemistry, Proceedings of the Academy of Sciences of the U.S.S.R. (New York)
ESTHA	Environmental Science and Technology (Washington)
ESTMA	Est Metallurgique (Besancon, France)
FUSJA	Fuel Society Journal, University of Sheffield (England
*GCABZ	GCA (Geophys. Corp. Am.), Bedford, Mass., GCA Technolo Division, Air Force Weapons Lab. Technical Reports
HCACA	Helvetica Chimica Acta (Basel)
HHHPA	Hua Hsueh Hsueh Pao (Peking)
IANKA	Izvestiia Akademii Nauk S.S.S.R., Otdelenie Khimischeskikh Nauk (Moscow)
IECHA	Industrial and Engineering Chemistry (Washington)

IJCKB International Journal of Chemical Kinetics (New York)

*IUAPZ International Union of Air Pollution Prevention Association (Washington, D.C., December 6-11, 1970) Preprint

JACSA Journal of the American Chemical Society (Washington)

JAPIA Journal of Applied Physics (New York)

JAPUA Journal of Applied Chemistry of the U.S.S.R. (New York) English Translation of Zh. Prikl. Khim.

JASMA Journal of the Acoustical Society of America (New York/Lancaster, Pa.)

JCPSA Journal of Chemical Physics (New York)

JCSIA Journal of the Chemical Society, A. Inorganic, Physical, Theoretical (London)

JCSØA Journal of the Chemical Society (London)

JEPØA Journal of Engineering for Power, Series A of the Transactions of the A.S.M.E. (American Society of Mechanical Engineers) (New York)

JPCAA Journal of the Air Pollution Control Association (Pittsburgh)

JPCHA Journal of Physical Chemistry (Washington/Ithaca, N.Y.)

JQSRA Journal of Quantitative Spectroscopy and Radiative Transfer (Øxford/New York)

KGKZA Kogyo Kagaku Zasshi (Tokyo)

KHVKA Khimiia Vysokikh Energii (Moscow)

MDPCA Memoirs of the Defense Academy, Mathematics, Physics, Chemistry and Engineering (Yokosuka City, Japan)

NACGA Nachrichten Der Akademie Der Wissenschaften in Goettingen, Mathematisch - Physikalische Klasse, Iia. Mathematisch - Physikalisch - Chemische Abteilung (Goettingen, Germany)

NASCA National Aeronautics and Space Administration, Technical Note (Washington)

NATUA Nature (London)

NUCIA Nuovo Cimento (Bologna, Italy)

ØPSUA Øptics and Spectroscopy USSR (Washington) English Translation of Øptika i Spektroskopiya

PHCBA Photochemistry and Photobiology, an International Journal (Øxford/New York)

PHYSA Physica (Amsterdam/Utrecht)

*PICFZ Proceedings of the International Conference on the Mechanism of Corrosion by Fuel Impurities (Marchwood, near Southampton, Hampshire, England, 20th-24th, May 1963)

PLSSA Planetary and Space Science, Including Translations Concerned with the Physical Sciences Published in "Iskusstvenny Sputniki Zemli" (Øxford)

PRLAA Proceedings of the Royal Society, Series A. Mathematical and Physical Sciences (London)

SCIEA Science. American Association for the Advancement of Science (Washington)

SYMCA Symposium on Combustion (International)

TELLA Tellus (Stockholm)

TFSØA Transactions of the Faraday Society (Aberdeen, Scotland/London)

ZAACA	Zeitschrift Fuer Anorganische Allgemeine Chemie (Leipzig/Hamburg)
ZEELA	Zeitschrift Fuer Elektrochemie (Weinheim/Halle, Germany)
ZEPCA	Zeitschrift Fuer Physikalische Chemie, Stoechiometrie und Verwandschaftslehre (Leipzig/Berlin)
ZETFA	Zhurnal Eksperimental'noi i Teoreticheskoi Fiziki (Moscow)
ZFKHA	Zhurnal Fizicheskoi Khimii (Moscow)
ZPCBA	Zeitschrift Fuer Physikalische Chemie, Abteilung B. Chemie Der Elementarprozesse, Aufbau Der Materie (Leipzig)
ZPCFA	Zeitschrift Fuer Physikalische Chemie (Frankfurt am Main)
ZPCLA	Zeitschrift Fuer Physikalische Chemie (Leipzig)
13DFA	Preprints of Papers Read at the International Symposium on Free Radicals, 5th Symposium, Uppsala, July 6-7, 1961
18MNA	Proceedings of the International Congress of Pure and Applied Chemistry, 11th Congress, London, July 17-24, 1947

I(a). REACTIONS OF CARBON OXYSULFIDES

$COS + COS \rightarrow CO_2 + CS_2$

Partington and Neville	JCSOA-1951-1230

$COS + h\nu \rightarrow CO + S$

Breckenridge, W. H., Jr.	DABBB-1969-30-1063 (mechanism)
Breckenridge and Taube	JCPSA-1970-53-1750
Forbes and Cline	JACSA-1939-61-151 (quantum yield)
Fowles, et al.	JACSA-1967-89-1352 (mechanism)
Jakovleva and Kondratjew	ACPYA-1940-13-241 (mechanism)
Kondratjew, V. N.	ACPYA-1942-16-272 (mechanism)
McGarvey and McGrath	PRLAA-1964-278-490 (mechanism)
Sidhu, et al.	JACSA-1966-88-2412
Strausz and Gunning	JACSA-1962-84-4080

$COS + h\nu \rightarrow CO + S^*$

Basco and Pearson	TFSOA-1967-63-2684 (mechanism)
Breckenridge, W. H., Jr.	DABBB-1969-30-1063 (mechanism)
Breckenridge and Taube	JCPSA-1970-53-1750
Donovan, R. J.	TFSOA-1969-65-1419 (mechanism)
Donovan, et al.	TFSOA-1970-66-774 (mechanism)
Fair, et al.	CJCHA-1971-49-1659 (mechanism)
Fowles, et al.	JACSA-1967-89-1352 (mechanism)
Gunning and Strausz	ADPCA-1966-4-143 (mechanism)
Knight, et al.	JACSA-1963-85-1207 (mechanism)
Knight, et al.	JACSA-1963-85-2349 (mechanism)
Knight, et al.	JACSA-1964-86-4243 (mechanism)
Kondrat'ev and Yakovleva	ZETFA-1940-10-1038 (mechanism)
Lown, et al.	JACSA-1967-89-1056
McGrath, et al.	CJCHA-1967-45-2454
Sidhu, et al.	JACSA-1966-88-254
Sidhu, et al.	JACSA-1966-88-2412
Strausz and Gunning	JACSA-1962-84-4080
Wiebe, et al.	JACSA-1965-87-1443

$COS + h\nu \rightarrow CS + O$

Kondrat'ev and Yakovleva	ZFKHA-1940-14-853
McGarvey and McGrath	PRLAA-1964-278-490 (mechanism)

$COS + H_2O \rightarrow CO_2 + H_2S$

Thompson, et al.	JCSOA-1935-1033

$COS + M \rightarrow CO + S + M$

Hay and Belford	JCPSA-1967-47-3944
Partington and Neville	JCSOA-1951-1230
Schecker and Wagner	IJCKB-1969-1-541
Troe and Wagner	BBPCA-1967-71-937 (review)

$COS + M^* \rightarrow CO + S + M$

Sidhu, et al.	JACSA-1966-88-2412

$COS + M^* \rightarrow COS + M$ (electronic relaxation)

Breckenridge and Taube	JCPSA-1970-53-1750

$COS + M^* \rightarrow COS^* + M$ (energy transfer)

Fowles, et al.	JACSA-1967-89-1352 (mechanism)
Gunning and Strausz	ADPCA-1966-4-143 (review)

$COS^* + M \rightarrow COS + M$ (vibrational relaxation)

Arnold, et al.	TFSOA-1957-53-738 (calculation)

COS^* + M → COS + M (vibrational relaxation) (Continued)

Cottrell and McCoubrey	BOOKA-1961-96 (review)
Eucken and Aybar	ZPCBA-1940-46-195
Fricke, E. F.	JASMA-1940-12-245
Herzfeld and Litovitz	BOOKA-1959-250 (review)
Knudsen and Fricke	JASMA-1940-12-255
McCoubrey, et al.	TFSOA-1951-57-1472 (review)
Walker, R. A.	JCPSA-1951-19-494 (review)

COS + O → CO + SO

Carrington, et al.	PRLAA-1966-293-108 (mechanism)
Hancock and Smith	CHPLB-1969-3-573 (mechanism)
Homann, et al.	NACGA-1967-2-13
Homann, et al.	BBPCA-1968-72-998
Hoyermann, et al.	BBPCA-1967-71-603
Rolfes, et al.	JPCHA-1965-69-849
Sharma, et al.	JCPSA-1965-43-2155
Sharma, et al.	JPCHA-1967-71-1602
Sullivan and Warneck	BBPCA-1965-69-7
Westenberg, A. A.	SCIEA-1969-164-381 (review)
Westenberg and deHaas	JCPSA-1969-50-707
Wright, F. J.	JPCHA-1960-64-1648 (mechanism)

COS + O → CO + SO^* (chemiexcitation)

Carrington, et al.	PRLAA-1966-293-108 (mechanism)

COS + O → CO^* + SO (chemiexcitation)

Pollack, M. A.	APPLA-1966-8-237 (mechanism)

COS + O → CO_2 + S

Arnold and Kimbell	CHPLB-1969-3-469 (mechanism)
Myerson, et al.	JCPSA-1957-26-1309 (mechanism)
Wright, F. J.	JPCHA-1960-64-1648 (mechanism)

COS + O → CS + O_2

Sheen, D. B.	JCPSA-1970-52-648

COS + O + SO → COS^* + SO_2^* (chemiexcitation)

Melliar-Smith, et al.	JCSIA-1971-606 (mechanism)

COS + O_2 → CO + SO_2

Bawn, C. E. H.	JCSOA-1933-145 (mechanism)
Levy and Merryman	ESTHA-1969-3-63
Myerson, et al.	JCPSA-1957-26-1309 (mechanism)

COS + $2O_2$ → CO_2 + O + SO_2

Bawn, C. E. H.	JCSOA-1933-145 (mechanism)

COS + $3/2O_2$ → CO_2 + SO_2 (overall)

Sarkisyan and Nalbandyan	DKPCA-1968-178-69 (related paper)
Thompson, et al.	JCSOA-1933-208

COS + S → CO + S_2

Basco and Pearson	TFSOA-1967-63-2684
Breckenridge, W. H., Jr.	DABBB-1969-30-1063
Breckenridge and Taube	JCPSA-1970-53-1750
Fowles, et al.	JACSA-1967-89-1352 (mechanism)
Gunning and Strausz	ADPCA-1966-4-143 (mechanism)
Hay, A. J.	DABSA-1967-27-2313

$C\O S + S \rightarrow C\O + S_2$ (Continued)

Hay and Belford	JCPSA-1967-47-3944
Knight, et al.	JACSA-1963-85-1207 (mechanism)
Knight, et al.	JACSA-1963-85-2349
Knight, et al.	JACSA-1964-86-4243
Kondratjew, V. N.	ACPYA-1942-16-272
Schecker and Wagner	IJCKB-1969-1-541
Sidhu, et al.	JACSA-1966-88-254
Sidhu, et al.	JACSA-1966-88-2412
Strausz and Gunning	JACSA-1962-84-4080
Wiebe, et al.	JACSA-1965-87-1443

$C\O S + S^* \rightarrow C\O + S_2$

Breckenridge, W. H., Jr.	DABBB-1969-30-1063
Breckenridge and Taube	JCPSA-1970-53-1750
Fowles, et al.	JACSA-1967-89-1352
Gunning and Strausz	ADPCA-1966-4-143 (review)
Knight, et al.	JACSA-1963-85-1207 (mechanism)
Knight, et al.	JACSA-1963-85-2349
Knight, et al.	JACSA-1964-86-4243
Sidhu, et al.	JACSA-1966-88-254
Sidhu, et al.	JACSA-1966-88-2412
Strausz and Gunning	JACSA-1962-84-4080
Wiebe, et al.	JACSA-1965-87-1443

$C\O S + S^* \rightarrow C\O + S_2^*$

Basco and Pearson	TFSØA-1967-63-2684 (mechanism)
Donovan, R. J.	TFSØA-1969-65-1419 (mechanism)
Donovan, et al.	NATUA-1969-222-1164
Donovan, et al.	TFSØA-1970-66-774
Fair, et al.	CJCHA-1971-49-1659
Fowles, et al.	JACSA-1967-89-1352 (mechanism)
McGrath, et al.	CJCHA-1967-45-2454 (mechanism)

$C\O S + S \rightarrow CS + S\O$

Hay, A. J.	DABSA-1967-27-2313
Hay and Belford	JCPSA-1967-47-3944

$C\O S + S + M \rightarrow C\O S_2 + M$

Basco and Pearson	TFSØA-1967-63-2684

$C\O S + S\O \rightarrow C\O_2 + S_2$

Halstead and Thrush	PRLAA-1966-295-363 (evaluation)

$C\O S_2 + M \rightarrow C\O S + S + M$

Basco and Pearson	TFSØA-1967-63-2684

$C\O S_2 + S \rightarrow C\O S + S_2$

Basco and Pearson	TFSØA-1967-63-2684

I(b). REVIEWS

Cottrell and McCoubrey	BOOKA-1961-95 (vibrational relaxation)
Gunning and Strausz	ADPCA-1966-4-143
Herzfeld and Litovitz	BOOKA-1959-250 (vibrational relaxation)
Sorokin and Fridman	BOOKA-1970-
Troe and Wagner	BBPCA-1967-71-937

II(a). REACTIONS OF CARBON SULFIDES

$CO_2 + CS_2 \rightarrow COS + COS$

Partington and Neville	JCSOA-1951-1230

$CS^* \rightarrow CS + h\nu$

Taylor, G. W.	ACSRA-1971-162-Phys. Chem. 14

$nCS \rightarrow (CS)_n$

Porter, G.	PRLAA-1950-200-284

$CS + CS + M \rightarrow C_2S_2 + M$

Kondratjew and Yakovleva	ZFKHA-1940-14-853

$CS + h\nu \rightarrow CS^*$

Callear and Norrish	NATUA-1960-188-53 (mechanism)
Kondratiew, V.	CRAUA-1938-20-547
de Sorgo, et al.	CJCHA-1965-43-1886 (mechanism)

$CS^* + M \rightarrow CS + M$ (vibrational relaxation)

Callear, A. B.	PRLAA-1963-276-401
Callear and Norrish	NATUA-1960-188-53 (mechanism)
Dyne and Ramsay	JCPSA-1952-20-1055
Kondratiew, V.	CRAUA-1938-20-547
Smith, I. W. M.	TFSOA-1968-64-3183
Taylor, G. W.	ACSRA-1971-162-Phys. Chem. 14

$CS + O \rightarrow CO + S$

Hancock and Smith	CHPLB-1969-3-573 (mechanism)
Harteck and Reeves	BSCBA-1962-71-682
Homann, et al.	BBPCA-1968-72-998
Jacobson and Kimbell	JAPIA-1970-41-5210 (mechanism)

$CS + O \rightarrow CO^* + S$ (chemiexcitation)

Arnold and Kimbell	APPLA-1969-15-351 (mechanism)
Arnold and Kimbell	CHPLB-1969-3-469 (review)
Hancock and Smith	CHPLB-1969-3-573
Jeffers and Wiswall	APPLA-1970-17-67
Suart, et al.	CHPLB-1970-5-519 (mechanism)
Suart, et al.	CHPLB-1970-7-337 (mechanism)
Wittig, et al.	APPLA-1970-16-117 (mechanism)
Wittig, et al.	NATUA-1970-226-845 (mechanism)

$CS + O + M \rightarrow COS + M$

Wright, F. J.	JPCHA-1960-64-1648

$CS + O_2 \rightarrow CO + SO$

McGarvey and McGrath	PRLAA-1964-278-490 (mechanism)
Rosenwaks and Yatsiv	CHPLB-1971-9-266 (mechanism)
Sheen, D. B.	JCPSA-1970-52-648
Wood and Heicklen	JPCHA-1971-75-854 (mechanism)
Wood and Heicklen	JPCHA-1971-75-861

$CS + O_2 \rightarrow CO^* + SO$ (chemiexcitation)

Arnold and Kimbell	APPLA-1969-15-351 (mechanism)
Suart, et al.	CHPLB-1970-5-519 (mechanism)
Suart, et al.	CHPLB-1970-7-337 (mechanism)

$CS + O_2 \rightarrow COS + O$

Arnold and Kimbell	CHPLB-1969-3-469 (review)
Wood and Heicklen	JPCHA-1971-75-861

$CS^* + O_2 \rightarrow COS + O$

Pollack, M. A.	APPLA-1966-8-237 (mechanism)
de Sorgo, et al.	CJCHA-1965-43-1886 (mechanism)

$CS + O_3 \rightarrow CO + SO_2$

Olszyna and Heicklen	JPCHA-1970-74-4188 (mechanism)

$CS + O_3 \rightarrow CO_2 + SO$

Olszyna and Heicklen	JPCHA-1970-74-4188 (mechanism)

$CS + O_3 \rightarrow COS + O_2$

Olszyna and Heicklen	JPCHA-1970-74-4188 (mechanism)

$CS + SO \rightarrow CO + S_2$

Wood and Heicklen	JPCHA-1971-75-854 (mechanism)

$CS + SO \rightarrow CO^* + S_2$ (chemiexcitation)

Pollack, M. A.	APPLA-1966-8-237 (mechanism)
Wright, F. J.	JPCHA-1960-64-1648

$CS + S_{2n} \rightarrow CS_2 + S_{2n-1}$

Breckenridge, W. H., Jr.	DABBB-1969-30-1063 (mechanism)

$CS_2^* \rightarrow CS_2 + h\nu$

Douglas, A. E.	JCPSA-1966-45-1007
Heicklen, J.	JACSA-1963-85-3562

$CS_2 + CS_2^* \rightarrow CS + CS + S_2$

de Sorgo, et al.	CJCHA-1965-43-1886
Wood and Heicklen	JPCHA-1971-75-854

$CS_2 + CS_2 \rightarrow CS + CS_3$

Arnold, et al.	JPCHA-1970-74-8

$CS_2 + h\nu \rightarrow CS + S$

Basco and Pearson	TFSOA-1967-63-2684 (mechanism)
Gregg and Thomas	JAPIA-1968-39-4399 (mechanism)
Gunning and Strausz	ADPCA-1966-4-143 (mechanism)
Hancock and Smith	CHPLB-1969-3-573 (mechanism)
Kondratjew and Yakovleva	ZFKHA-1940-14-853
McGarvey and McGrath	PRLAA-1964-278-490
Pollack, M. A.	APPLA-1966-8-237 (mechanism)
Wright, F. J.	JPCHA-1960-64-1648 (mechanism)

$CS_2 + h\nu \rightarrow CS + S^*$

Kondrat'ev and Yakovleva	ZETFA-1940-10-1038 (mechanism)

$CS_2 + h\nu \rightarrow CS^* + S$

Callear, A. B.	PRLAA-1963-276-401

$CS_2 + h\nu \rightarrow CS^* + S$ (Continued)

Callear and Norrish	NATUA-1960-188-53 (mechanism)
de Sorgo, et al.	CJCHA-1965-43-1886 (mechanism)

$CS_2 + h\nu \rightarrow CS_2^*$

Heicklen, J.	JACSA-1963-85-3562 (mechanism)
de Sorgo, et al.	CJCHA-1965-43-1886 (mechanism)
Wood and Heicklen	JPCHA-1971-75-854

$CS_2 + M \rightarrow CS + S + M$

Arnold, et al.	JPCHA-1970-74-8
Arnold and Kimbell	APPLA-1969-15-351 (mechanism)
Arnold and Kimbell	JPCHA-1969-73-3751
Gaydon, et al.	PRLAA-1964-279-313 (mechanism)
Olschewski, et al.	ZPCFA-1965-45-329
Olschewski, et al.	BBPCA-1966-70-1060
Troe and Wagner	BBPCA-1967-71-937 (review)

$CS_2 + M^* \rightarrow CS_2^* + M$ (energy transfer)

Taylor, G. W.	ACSRA-1971-162-Phys. Chem. 14

$CS_2^* + M \rightarrow CS_2 + M$ (electronic relaxation)

Heicklen, J.	JACSA-1963-85-3562
Wood and Heicklen	JPCHA-1971-75-854

$CS_2^* + M \rightarrow CS_2 + M$ (vibrational relaxation)

Angona, F. A.	JASMA-1953-25-1116
Cottrell and McCoubrey	BOOKA-1961-95 (review)
Fricke, E. F.	JASMA-1940-12-245
Gase, et al.	ZPCLA-1970-242-107 (calculation)
Gravitt, J. C.	JASMA-1960-32-560
Herzfeld and Litovitz	BOOKA-1959-250 (review)
Knudsen and Fricke	JASMA-1940-12-255
McCoubrey, et al.	TFSOA-1961-57-1472 (review)
Richards and Reid	JCPSA-1934-2-193

$CS_2 + N \rightarrow CS + NS$

Westbury and Winkler	CJCHA-1960-38-334

$CS_2 + O \rightarrow CO^* + S_2$ (chemiexcitation)

Arnold and Kimbell	CHPLB-1969-3-469 (mechanism)
Gregg and Thomas	JAPIA-1968-39-4399 (mechanism)
Pollack, M. A.	APPLA-1966-8-237 (mechanism)

$CS_2 + O \rightarrow COS + S$

Arnold and Kimbell	CHPLB-1969-3-469 (mechanism)
Callear and Smith	NATUA-1967-213-382
Hancock and Smith	CHPLB-1969-3-573 (review)
Homann, et al.	BBPCA-1968-72-998
McGarvey and McGrath	PRLAA-1964-278-490 (mechanism)
Myerson, et al.	JCPSA-1957-26-1309 (mechanism)
Pollack, M. A.	APPLA-1966-8-237 (mechanism)
Sharma, et al.	JCPSA-1965-43-2155
Sheen, D. B.	JCPSA-1970-52-648
Westenberg, A. A.	SCIEA-1969-164-381 (review)
Wright, F. J.	JPCHA-1960-64-1648 (mechanism)

$CS_2 + O \rightarrow CS + SO$

Arnold and Kimbell	APPLA-1969-15-351 (mechanism)
Arnold and Kimbell	CHPLB-1969-3-469 (mechanism)
Callear and Smith	NATUA-1967-213-382
Hancock and Smith	CHPLB-1969-3-573 (review)
Harteck and Reeves	BSCBA-1962-71-682
Homann, et al.	BBPCA-1968-72-998
Jeffers and Wiswall	APPLA-1970-17-67
Myerson, et al.	JCPSA-1957-26-1309 (mechanism)
Olszyna and Heicklen	JPCHA-1970-74-4188
Rosenwaks and Yatsiv	CHPLB-1971-9-266 (mechanism)
Smith, I. W. M.	DFSOA-1967-44-194
Smith, I. W. M.	TFSOA-1968-64-378
Suart, et al.	CHPLB-1970-5-519 (mechanism)
Suart, et al.	CHPLB-1970-7-337 (mechanism)
Westenberg and deHaas	JCPSA-1969-50-707
Wittig, et al.	APPLA-1970-16-117 (mechanism)
Wittig, et al.	NATUA-1970-226-845 (mechanism)
Wood and Heicklen	JPCHA-1971-75-854
Wood and Heicklen	JPCHA-1971-75-861

$CS_2^* + O_2 \rightarrow COS + SO$

Wood and Heicklen	JPCHA-1971-75-854

$CS_2 + O_2 \rightarrow CS + SO_2$

Azatyan, et al.	DKPCA-1964-158-869 (related paper)
Myerson, et al.	JCPSA-1957-26-1309 (mechanism)
Taylor and Myerson	SYMCA-1959-7-72 (related paper)

$CS_2^* + O_2 \rightarrow CS + SO_2$

de Sorgo, et al.	CJCHA-1965-43-1886
Wood and Heicklen	JPCHA-1971-75-854

$CS_2 + O_2 + M \rightarrow . . .$

Semenoff and Voronkov	ACPYA-1940-12-831 (related paper)
Voronkov and Semenov	ZFKHA-1939-13-1695 (related paper)

$CS_2 + 3O_2 \rightarrow CO_2 + 2SO_2$

Myerson and Taylor	JACSA-1953-75-4348
Taylor and Myerson	SYMCA-1959-7-72
Thompson, H. W.	ZPCBA-1930-10-273 (related paper)

$CS_2 + S \rightarrow CS + S_2$

Porter, G.	PRLAA-1950-200-284
Wright, F. J.	JPCHA-1960-64-1648 (mechanism)

$CS_2 + S^* \rightarrow CS + S_2$

Breckenridge, W. H., Jr.	DABBB-1969-30-1063

$CS_2 + S + M \rightarrow CS_3 + M$

Basco and Pearson	TFSOA-1967-63-2684
Breckenridge, W. H., Jr.	DABBB-1969-30-1063

$CS_2 + SO \rightarrow COS + S_2$

Wood and Heicklen	JPCHA-1971-75-861

$CS_2 + SO \rightarrow CS + S_2O$

Wright, F. J.	JPCHA-1960-64-1648 (mechanism)

$CS_2 + SO_2 \rightarrow CS + S_2O_2$

Myerson, et al — JCPSA-1957-26-1309 (mechanism)

$CS_3 + M \rightarrow CS_2 + S + M$

Arnold, et al. — JPCHA-1970-74-8
Basco and Pearson — TFSOA-1967-63-2684

$CS_3 + M \rightarrow CS_2 + 1/8S_8 + M$

Breckenridge, W. H., Jr. — DABBB-1969-30-1063

$CS_3 + S \rightarrow CS_2 + S_2$

Basco and Pearson — TFSOA-1967-63-2684

II(b). REVIEWS

Cottrell and McCoubrey — BOOKA-1961-95 (vibrational relaxation

Gunning and Strausz — ADPCA-1966-4-143

Herzfeld and Litovitz — BOOKA-1959-250 (vibrational relaxatic

Troe and Wagner — BBPCA-1967-71-937

III(a). REACTIONS OF SULFUR, SULFUR HYDRIDES AND SULFUR OXIDES

$CO + SO_2 \rightarrow CO_2 + SO$ (overall)

Bauer, et al.	SYMCA-1971-13-417

$CO + SO_2^* \rightarrow CO_2 + SO$

Bauer, et al.	SYMCA-1971-13-417

$CO^* + SO_2 \rightarrow CO_2 + SO$

Bauer, et al.	SYMCA-1971-13-417

$CO + SO_3 \rightarrow CO_2 + SO_2$

Bauer, et al.	SYMCA-1971-13-417 (mechanism)

$D + D_2S \rightarrow D_2 + SD$

Darwent and Roberts	DFSOA-1953-14-55

$D + H_2S \rightarrow HD + SH$

Yokota, T.	DABSA-1969-29-4136

$D_2^* + H_2S \rightarrow HD^* + HDS$

Burcat, et al.	JCPSA-1968-49-1449

$D_2S + H_2S \rightarrow HDS + HDS$

Pyper and Newbury	JCPSA-1970-52-1966

$H + H_2S \rightarrow H_2 + SH$

Compton, et al.	JPCHA-1969-73-1158
Cupitt and Glass	TFSOA-1970-66-3007
Darwent and Krasnansky	SYMCA-1959-7-3
Darwent and Roberts	DFSOA-1953-14-55
Darwent and Roberts	PRLAA-1953-216-344 (mechanism)
Darwent, et al.	13DFA-1961-14
Darwent, et al.	JPCHA-1967-71-2346
Dzantiev, et al.	KHVKA-1968-2-571
Forbes, et al.	JACSA-1938-60-1431 (mechanism)
Fowles, et al.	JACSA-1967-89-1352
Gann and Dubrin	JCPSA-1967-47-1867
Kurylo, et al.	JCPSA-1971-54-943
Levy and Merryman	CBFMA-1965-9-229
Liuti, et al.	JACSA-1966-88-3212 (mechanism)
Mihelcic and Schindler	BBPCA-1970-74-1280
Norrish and Zeelenberg	PRLAA-1957-240-293 (related paper)
Perner and Franken	BBPCA-1969-73-897
Stein, N. O.	TFSOA-1933-29-583 (mechanism)
Wadlinger and Darwent	JPCHA-1967-71-2057
Woolley and Cvetanović	JCPSA-1969-50-4697
Yokota, T.	DABSA-1969-29-4136
Zeelenberg, A. P.	SYMCA-1959-7-68 (related paper)

$H^* + H_2S \rightarrow H_2 + SH$

Yokota, T.	DABSA-1969-29-4136

$H^* + H_2S \rightarrow H_2 + SH^*$

Dzantiev, et al.	KHVKA-1970-4-361
Dzantiev, et al.	KHVKA-1970-4-545

$H + HSO_2 \rightarrow H_2 + SO_2$

Halstead and Jenkins	TFSOA-1969-65-3013

$H + SH \rightarrow H_2 + S$

Cupitt and Glass	TFSOA-1970-66-3007
Fair and Thrush	TFSOA-1969-65-1557
Mayer and Schieler	JPCHA-1968-72-236 (calculation)
Mihelcic and Schindler	BBPCA-1970-74-1280

$H + SO_2 + M \rightarrow HSO_2 + M$

Fair and Thrush	TFSOA-1969-65-1550
Fenimore and Jones	JPCHA-1965-69-3593
Halstead and Jenkins	TFSOA-1969-65-3013
Kallend, A. S.	JPCHA-1966-70-2055
Kallend, A. S.	TFSOA-1967-63-2442
Kallend, A. S.	CBFMA-1969-13-324
Schofield, K.	PLSSA-1967-15-643
Webster and Walsh	SYMCA-1965-10-463
Wheeler, R.	JPCHA-1968-72-3359

$H + SO_3 \rightarrow OH + SO_2$

Fenimore and Jones	JPCHA-1965-69-3593
Merryman and Levy	SYMCA-1971-13-427

$H_2 + S \rightarrow H + SH$

Mayer and Schieler	JPCHA-1968-72-236

$H_2 + S^* \rightarrow H + SH$

Donovan, et al.	TFSOA-1970-66-774

$H_2 + S + h\nu \rightarrow H_2S$

Norrish and Rideal	JCSOA-1924-125-2070

$H_2 + S (+ M) \rightarrow H_2S (+ M)$

Aynsley and Robinson	JCSOA-1935-351
Aynsley, et al.	NATUA-1933-131-471
Aynsley, et al.	JCSOA-1935-58
Bodenstein, M.	ZEPCA-1899-29-315
Norrish and Rideal	JCSOA-1923-123-696
Norrish and Rideal	JCSOA-1923-123-1689
Norrish and Rideal	JCSOA-1924-125-2070
Porret, D.	HCACA-1936-19-680
Reinhold, et al.	ZPCAA-1939-184-273

$H_2 + S^* (+ M) \rightarrow H_2S^* (+ M)$

Fowles, et al.	JACSA-1967-89-1352
Gunning and Strausz	ADPCA-1966-4-143 (mechanism)

$H_2 + SO_3 \rightarrow H_2O + SO_2$

Levy and Merryman	CBFMA-1965-9-229

$H_2 + S_2 \rightarrow H_2S + S$

Aynsley, et al.	JCSOA-1935-58 (mechanism)
Porret, D.	HCACA-1936-19-680

$H_2 + S_2 \rightarrow H_2S_2^*$

Majerik, J. W.	DABBB-1970-31-555

$H_2 + S_6 \rightarrow H_2S + S_5$

Porret, D. HCACA-1936-19-680

$H_2O + NO_2 + O_2 + RH + SO_2 \rightarrow . . .$

Urone, et al. ESTHA-1968-2-611

$H_2O + NO_2 + O_2 + RH + SO_2 + h\nu \rightarrow . . .$

Urone, et al. ESTHA-1968-2-611

$H_2O + O_2 + SO_2 \rightarrow . . .$

Urone, et al. ESTHA-1968-2-611

$H_2O + O_2 + SO_2 + h\nu \rightarrow . . .$

Urone, et al. ESTHA-1968-2-611

$H_2O + SO + S_2O_2 \rightarrow H_2S + SO_2 + SO_2$

Emanuel, N. M. IANKA-1942-221

$H_2S + h\nu \rightarrow H + SH$

Compton, et al.	JPCHA-1969-73-1158
Darwent, B. deB.	DFSOA-1953-14-123
Darwent and Krasnansky	SYMCA-1959-7-3 (quantum yield)
Darwent and Roberts	PRLAA-1953-216-344
Darwent, et al.	13DFA-1961-14
Dzantiev and Shishkov	KHVKA-1967-1-192
Forbes, et al.	JACSA-1938-60-1431
Fowles, et al.	JACSA-1967-89-1352
McGarvey and McGrath	PRLAA-1964-278-490 (related paper)
Majerik, J. W.	DABBB-1970-31-555 (mechanism)
Norrish and Zeelenberg	PRLAA-1957-240-293 (related paper)
Porter, G.	DFSOA-1953-14-123
Stein, N. O.	TFSOA-1933-29-583 (quantum yield)
Wadlinger and Darwent	JPCHA-1967-71-2057
Zeelenberg, A. P.	SYMCA-1959-7-68 (related paper)

$H_2S + h\nu \rightarrow H_2 + S$

Compton, et al. JPCHA-1969-73-1158

$H_2S + h\nu \rightarrow H_2 + S^*$

Stein, N. O. TFSOA-1933-29-583 (quantum yield)

$H_2S (+ M) \rightarrow H + SH (+ M)$

Levy and Merryman CBFMA-1965-9-229

$H_2S^* (+ M) \rightarrow H + SH (+ M)$

Gunning and Strausz ADPCA-1966-4-143 (mechanism)

$H_2S (+ M) \rightarrow H_2 + 1/2S_2 (+ M)$

Darwent and Roberts PRLAA-1953-216-344

$H_2S^* + M \rightarrow H_2S + M$ (rotational relaxation)

Bauer, et al.	PHYSA-1970-47-109
Geide, K.	ACUSA-1963-13-31

$H_2S^* + M \rightarrow H_2S + M$ (vibrational relaxation)

Bauer, et al.	PHYSA-1970-47-109
Shields, F. D.	JASMA-1969-45-481

$H_2S + N \rightarrow H_2 + NS$

Westbury and Winkler	CJCHA-1960-38-334

$H_2S + O \rightarrow H_2 + SO$

Bradley, J. N.	TFSOA-1967-63-2945 (mechanism)
Bradley and Dobson	JCPSA-1967-46-2865
Bradley and Dobson	JCPSA-1967-46-2872
Sachyan, et al.	DKPCA-1967-175-647
Sharma, et al.	JCPSA-1965-43-2155 (mechanism)
Sharma, et al.	JPCHA-1967-71-1602

$H_2S + O \rightarrow OH + SH$

Bradley, J. N.	TFSOA-1967-63-2945 (mechanism)
Bradley and Dobson	JCPSA-1967-46-2865
Bradley and Dobson	JCPSA-1967-46-2872
Cupitt and Glass	TFSOA-1970-66-3007
Hollinden, et al.	JPCHA-1970-74-988
Levy and Merryman	CBFMA-1965-9-229
Liuti, et al.	JACSA-1966-88-3212
Merryman and Levy	JPCAA-1967-17-800
Norrish and Zeelenberg	PRLAA-1957-240-293 (related paper)
Sachyan, et al.	DKPCA-1967-175-647
Takahashi, S.	MDPCA-1970-10-369
Zeelenberg, A. P.	SYMCA-1959-7-68 (related paper)

$H_2S + OH \rightarrow H_2O + SH$

Bradley, J. N.	TFSOA-1967-63-2945 (mechanism)
Bradley and Dobson	JCPSA-1967-46-2865
Bradley and Dobson	JCPSA-1967-46-2872
Levy and Merryman	CBFMA-1965-9-229
Levy and Merryman	JEPOA-1965-87-116
Zeelenberg, A. P.	SYMCA-1959-7-68 (related paper)

$H_2S + O_2 \rightarrow H_2O + SO$

Levy and Merryman	JEPOA-1965-87-116

$H_2S + 3/2O_2 \rightarrow H_2O + SO_2$

Chamberlin and Clarke	IECHA-1928-20-1016 (related paper)
Emanuel, N. M.	ZFKHA-1940-14-863
Emanuel, N. M.	CRAUA-1942-35-250
Emanuel, N. M.	CRAUA-1942-36-145
Emanuel, N. M.	ACPYA-1944-19-360
Emanuel, N. M.	ZFKHA-1945-19-15
Emanuel, et al.	CRAUA-1940-28-618
Farkas, L.	ZEELA-1931-37-670
Levy and Merryman	JEPOA-1963-85-229 (review)
Markovich and Emanuel	ZFKHA-1947-21-1251
Markovich and Emanuel	ZFKHA-1947-21-1259
Pavlov, et al.	IANKA-1942-98
Semenov and Emanuel	CRAUA-1940-28-219
Taylor and Livingston	JPCHA-1931-35-2676
Thompson, H. W.	NATUA-1931-127-629
Thompson and Kelland	JCSOA-1931-1809
Yakovlev and Shantarovich	ACPYA-1937-6-71

$H_2S + O_3 \rightarrow H_2O + H_2SO_4 + SO_2$ (overall)

Gregor and Martin	AJCHA-1961-14-462 (related paper)

$H_2S + O_3 \rightarrow H_2O + SO_2$

Cadle and Ledford	AWPOA-1966-10-25
Gregor and Martin	AJCHA-1961-14-462 (related paper)
Hales, J. M.	DABSA-1968-29-985
Hales, et al.	ATENB-1969-3-657

$H_2S + S^* \rightarrow H_2 + S_2$

Stein, N. O.	TFSOA-1933-29-583 (mechanism)

$H_2S + 1/2SO_2 \rightarrow H_2O + 3/2S$

Taylor and Wesley	JPCHA-1927-31-216

$H_2S_2^* \rightarrow H_2 + S_2$

Majerik, J. W.	DABBB-1970-31-555
Perner and Franken	BBPCA-1969-73-897

$H_2S_2^* \rightarrow SH + SH$

Majerik, J. W.	DABBB-1970-31-555

$H_2S_2 + h\nu \rightarrow SH + SH$

Strausz, et al.	BBPCA-1968-72-253 (mechanism)

$H_2S_2^* + M \rightarrow H_2S_2 + M$

Majerik, J. W.	DABBB-1970-31-555 (mechanism)

$HSO_2 + OH \rightarrow H_2O + SO_2$

Halstead and Jenkins	TFSOA-1969-65-3013

$N + SO \rightarrow NO + S$

Liuti, G.	AANLA-1968-45-358

$N_2O + S^* \rightarrow N_2 + SO$

Breckenridge and Taube	JCPSA-1970-53-1750

$N_2O + SO_2 \rightarrow N_2 + SO_3$ (overall)

Bell, et al.	JCSOA-1955-1440
Reuben, et al.	SYMCA-1962-8-97

$N_2O_5 + SO_2 \rightarrow 2NO_2 + SO_3$

Wilson, et al.	*APCPZ-1970-70-115 (mechanism)

$NO + O_2 + SO_2 \rightarrow NO_2 + SO_3 + . . .$ (overall)

Tipper and Williams	TFSOA-1961-57-79

$NO + O_2 + SO_2$ ($+ H_2O +$ hydrocarbons) $+ h\nu \rightarrow . . .$

Wilson and Levy	JPCAA-1970-20-385 (mechanism)

$NO + S + M \rightarrow NOS + M$

Basco and Pearson	TFSOA-1967-63-2684

$3NO_2 + H_2O + 2SO_2 \rightarrow NO + 2NOHSO_4$

Stopperka, et al.	ZAACA-1968-359-14

$NO_2 + SO \rightarrow NO + SO_2$

Clyne, et al.	PRLAA-1966-295-355

$NO_2 + SO_2 \rightarrow NO + SO_3$

Armitage and Cullis	CBFMA-1971-16-125
Boreskov and Ilarionov	ZFKHA-1940-14-1428
Cullis, et al.	PRLAA-1966-295-72
Kerr, J. A.	CSAAA-1967-64-73 (review)
Shaw and Green	NATUA-1966-211-1171
Urone, et al.	ESTHA-1968-2-611 (related paper)
Wilson, et al.	*APCPZ-1970-70-115 (mechanism)

$NO_2 + SO_2$ (+ M) $\rightarrow$ . . .

Ripperton, et al.	ACSRA-1965-150-19.X
Ripperton, et al.	ACSRA-1964-147-20.R
Tipper and Williams	TFSOA-1961-57-79
Wilson and Levy	JPCAA-1970-20-385

$NO_2 + SO_3 \rightarrow NO_3 + SO_2$

Wilson, et al.	*APCPZ-1970-70-115 (mechanism)

$NO_3 + SO_2 \rightarrow NO_2 + SO_3$

Cullis, et al.	PRLAA-1966-295-72

$NOS + S \rightarrow NO + S_2$

Basco and Pearson	TFSOA-1967-63-2684

$O + S + M \rightarrow SO + M^*$ (chemiexcitation)

Tewarson and Palmer	SYMCA-1971-13-99 (mechanism)

$O + S + M \rightarrow SO^* + M$ (chemiexcitation)

Fair and Thrush	TFSOA-1969-65-1557

$O + SH \rightarrow H + SO$

Cupitt and Glass	TFSOA-1970-66-3007
Liuti, et al.	JACSA-1966-88-3212 (mechanism)
Takahashi, S.	MDPCA-1970-10-369

$O + SO \rightarrow SO_2 + h\nu$

Cohen and Gross	JCPSA-1969-50-3119
Fletcher and Levitt	TFSOA-1969-65-1544
Gaydon, A. G.	PRLAA-1934-146-901 (mechanism)
Harteck and Reeves	BSCBA-1962-71-682
Herman, et al.	JQSRA-1962-2-215 (mechanism)
Liuti, G.	AANLA-1968-45-358 (mechanism)
Reeves and Emerson	JCPSA-1970-52-2161 (mechanism)
Rolfes, et al.	JPCHA-1965-69-849
Sharma, et al.	JCPSA-1965-43-2155 (mechanism)
Sharma, et al.	JPCHA-1967-71-1602
Takahashi, S.	MDPCA-1970-10-369
Williams, D. J.	CBFMA-1968-12-165
Zeelenberg, A. P.	SYMCA-1959-7-68 (mechanism)

$O + SO + M \rightarrow SO_2 + M$

Bauer, S. H.	ARPLA-1965-16-245 (review)
Gaydon, A. G.	PRLAA-1934-146-901 (mechanism)
Gaydon, et al.	PRLAA-1963-276-461 (mechanism)
Halstead and Thrush	PHCBA-1965-4-1007
Halstead and Thrush	PRLAA-1966-295-363
Kerr, J. A.	CSAAA-1967-64-73 (review)

$O + SO + M \rightarrow SO_2 + M$ (Continued)

McGarvey and McGrath	PRLAA-1964-278-490 (related paper)
Norrish and Oldershaw	PRLAA-1959-249-498 (related paper)
Sharma, et al.	JPCHA-1967-71-1602
Takahashi, S.	MDPCA-1970-10-369
Zeelenberg, A. P.	SYMCA-1959-7-68 (related paper)

$O + SO + M \rightarrow SO_2^* + M$ (chemiexcitation)

Bradley and Dobson	JCPSA-1967-47-1555
Fletcher and Levitt	TFSOA-1969-65-1544 (mechanism)
Halstead and Thrush	NATUA-1964-204-992 (mechanism)
Halstead and Thrush	PRLAA-1966-295-363
McGarvey and McGrath	PRLAA-1964-278-490 (related paper)
Melliar-Smith, et al.	JCSIA-1971-606 (mechanism)
Norrish and Zeelenberg	PRLAA-1957-240-293 (related paper)
Rolfes, et al.	JPCHA-1965-69-849 (mechanism)
Takahashi, S.	MDPCA-1970-10-369

$O + SO + M \rightarrow SO_2^* + M^*$ (chemiexcitation)

Melliar-Smith, et al.	JCSIA-1971-606 (mechanism)

$O + SO_2 \rightarrow O + SO_2$ (exchange)

Clark, et al.	JCPSA-1970-52-4692

$O + SO_2 + M \rightarrow SO_3 + M$

Baldwin, R. R.	SYMCA-1965-10-470
Bell, et al.	JCSOA-1955-1440
Cadle and Powers	TELLA-1966-18-176
Dooley and Whittingham	TFSOA-1946-42-354 (related paper)
Driscoll and Warneck	JPCHA-1968-72-3736
Fenimore and Jones	JPCHA-1965-69-3593
Halstead and Thrush	PHCBA-1965-4-1007
Halstead and Thrush	PRLAA-1966-295-363
Hedley, A. B.	FUSJA-1962-13-45
Hedley, A. B.	*PICFZ-1963-204
Jakovleva and Kondratjew	ACPYA-1940-13-241 (mechanism)
Kaufman, F.	PRLAA-1958-247-123
Levy and Merryman	CBFMA-1965-9-229
Levy and Merryman	JEPOA-1963-85-229 (review)
Levy and Merryman	JEPOA-1965-87-116
Levy and Merryman	JEPOA-1965-87-374
Merryman and Levy	SYMCA-1971-13-427
Mulcahy, et al.	SYMCA-1969-12-323
Mulcahy, et al.	JPCHA-1967-71-2124
Myerson, et al.	JCPSA-1957-26-1309 (mechanism)
Nettleton and Stirling	SYMCA-1969-12-635
Reuben, et al.	SYMCA-1962-8-97
Schofield, K.	PLSSA-1967-15-643
Sullivan, et al.	NASCA-1961-N62-15918
Thrush, B. A.	SYMCA-1965-10-470
Tipper and Williams	TFSOA-1960-56-1805
Walsh, A. D.	SYMCA-1965-10-470
Webster and Walsh	SYMCA-1965-10-463
Whittingham, G.	18MNA-1947-4-591 (related paper)
Whittingham, G.	SYMCA-1949-3-453 (related paper)

$O + SO_2 (+ M) \rightarrow SO_3^* (+ M)$

Jaffe and Klein	TFSOA-1966-62-2150
Tipper and Williams	TFSOA-1960-56-1805 (mechanism)

$O + SO_3 \rightarrow O_2 + SO_2$

Fenimore and Jones	JPCHA-1965-69-3593

$O + SO_3 \rightarrow O_2 + SO_2$ (Continued)

Merryman and Levy	SYMCA-1971-13-427
Nettleton and Stirling	SYMCA-1969-12-635
Norrish and Oldershaw	PRLAA-1959-249-498 (related paper)

$O + S_2 \rightarrow S + SO$

Homann, et al.	BBPCA-1968-72-998

$OH + OH + SO_2 \rightarrow H_2O + SO_3$

McAndrew and Wheeler	JPCHA-1962-66-229

$OH + SO \rightarrow H + SO_2$

Cupitt and Glass	TFSOA-1970-66-3007
Fair and Thrush	TFSOA-1969-65-1557

$OH + SH \rightarrow H_2 + SO$

Zeelenberg, A. P.	SYMCA-1959-7-68 (mechanism)

$O_2 + S \rightarrow O + SO$

Cupitt and Glass	TFSOA-1970-66-3007
Davis and Pilling	ACSRA-1971-162-Phys. Chem. 6
Fair and Thrush	TFSOA-1969-65-1557
Fair, et al.	CJCHA-1971-49-1659
Gregg and Thomas	JAPIA-1968-39-4399 (mechanism)
Hancock and Smith	CHPLB-1969-3-573 (mechanism)
Harteck and Reeves	BSCBA-1962-71-682
Homann, et al.	BBPCA-1968-72-998
Homann, et al.	BBPCA-1969-73-967
McGarvey and McGrath	PRLAA-1964-278-490 (related paper)
Myerson, et al.	JCPSA-1957-26-1309 (mechanism)
Pollack, M. A.	APPLA-1966-8-237 (mechanism)
Wittig, et al.	NATUA-1970-226-845 (mechanism)
Wright, F. J.	JPCHA-1960-64-1648 (mechanism)

$O_2 + S \rightarrow SO_2 + SO_3$ (overall)

Semenoff and Rjabinin	ZPCBA-1928-1-192 (related paper)

$O_2 + S + M \rightarrow SO_2 + M$

Norrish and Rideal	JCSOA-1923-123-1689
Norrish and Rideal	JCSOA-1923-123-3202

$O_2 + S^* + M \rightarrow SO_2 + M$

Kondrat'ev and Yakovleva	ZETFA-1940-10-1038 (mechanism)

$O_2 + SH \rightarrow OH + SO$

Bradley, J. N.	TFSOA-1967-63-2945 (mechanism)
Bradley and Dobson	JCPSA-1967-46-2865
Bradley and Dobson	JCPSA-1967-46-2872
McGarvey and McGrath	PRLAA-1964-278-490 (related paper)
Norrish and Zeelenberg	PRLAA-1957-240-293 (related paper)
Zeelenberg, A. P.	SYMCA-1959-7-68 (related paper)

$O_2 + SO (+ M) \rightarrow O + SO_2 (+ M)$

Bradley, J. N.	TFSOA-1967-63-2945 (review)
Bradley and Dobson	JCPSA-1967-46-2865
Bradley and Dobson	JCPSA-1967-46-2872
Driscoll and Warneck	JPCHA-1968-72-3736
Harteck and Reeves	BSCBA-1962-71-682
Homann, et al.	BBPCA-1968-72-998

$O_2 + SO (+ M) \rightarrow O + SO_2 (+ M)$ (Continued)

Homann, et al.	BBPCA-1969-73-967
Levy and Merryman	CBFMA-1965-9-229
Levy and Merryman	JEPOA-1965-87-374
McGarvey and McGrath	PRLAA-1964-278-490 (related paper)
Merryman and Levy	JPCAA-1967-17-800
Myerson and Taylor	JCPSA-1957-26-1309 (mechanism)
Norrish and Oldershaw	PRLAA-1959-249-498 (related paper)
Norrish and Zeelenberg	PRLAA-1957-240-293 (related paper)
Sachyan, et al.	DKPCA-1967-175-647 (mechanism)
Sheen, D. B.	JCPSA-1970-52-648
Williams, D. J.	CBFMA-1968-12-165
Wood and Heicklen	JPCHA-1971-75-861
Zeelenberg, A. P.	SYMCA-1959-7-68 (related paper)

$1/2O_2 + SO (+ M) \rightarrow SO_2 (+ M)$

Gaydon, et al.	PRLAA-1963-276-461
Levy and Merryman	JEPOA-1965-87-116

$O_2 + SO + M \rightarrow SO_3 + M$

Driscoll and Warneck	JPCHA-1968-72-3736
Levy and Merryman	CBFMA-1965-9-229
Levy and Merryman	JEPOA-1965-87-374
Myerson, et al.	JCPSA-1957-26-1309 (mechanism)
Norrish and Oldershaw	PRLAA-1959-249-498 (related paper)
Wood and Heicklen	JPCHA-1971-75-854
Wood and Heicklen	JPCHA-1971-75-861

$O_2 + SO_2^* \rightarrow O + SO_3$

Driscoll and Warneck	JPCHA-1968-72-3736

$O_2 + SO_2^* \rightarrow SO_4$

Blacet, F. E.	IECHA-1952-44-1339 (mechanism)
Dunham, S. B.	NATUA-1960-188-51 (mechanism)
Gerhard and Johnstone	IECHA-1955-47-972
Katz and Gale	*IUAPZ-1970-CP-1E
Shirai, et al.	KGKZA-1962-65-1906 (mechanism)

$1/2O_2 + SO_2 + h\nu \rightarrow SO_3$ (overall)

Arin, et al.	*GCABZ-1969-RPT/GCA-TR-69-12-G
Chen, S. W.	HHHPA-1958-24-187
Coehn, A.	ZEELA-1907-13-545
Coehn and Becker	ZEPCA-1910-70-88
Cox and Penkett	ATENB-1970-4-341
Kornfeld and Weegman	ZEELA-1930-36-789
Shirai, et al.	KGKZA-1962-65-1906
Sullivan, et al.	NASCA-1961-RPT/GCA-TR-61-17-N

$O_2 + SO_2 + M \rightarrow \ . \ . \ .$

Cullis, et al.	CBFMA-1967-11-150
Urone, et al.	ESTHA-1968-2-611 (related paper)

$1/2O_2 + SO_2 + M \rightarrow SO_3 + M$

Cox and Penkett	ATENB-1970-4-341
Cullis, et al.	PRLAA-1966-295-72
Levy and Merryman	JEPOA-1963-85-229 (review)
Levy and Merryman	JEPOA-1965-87-116
Merryman and Levy	SYMCA-1971-13-427
Nikolov, et al.	JAPUA-1970-43-2340

$O_2 + SO_3 \rightarrow 1/2O_2 + SO_4$

Katz and Gale	*IUAPZ-1970-CP-1E

$O_2 + SO_3^* \rightarrow O_3 + SO_2$

Tipper and Williams	TFSOA-1960-56-1805 (mechanism)

$1/2O_2 + SO_4 \rightarrow O_2 + SO_3$

Katz and Gale	*IUAPZ-1970-CP-1E

$O_2 + SO_4 \rightarrow O_3 + SO_3$

Blacet, F. E.	IECHA-1952-44-1339 (mechanism)
Dunham, S. B.	NATUA-1960-188-51 (mechanism)
Shirai, et al.	KGKZA-1962-65-1906 (mechanism)

$O_2 + S_2 \rightarrow S + SO_2$

Kondratjew, V. N.	ACPYA-1942-16-272 (mechanism)

$O_3 + SO \rightarrow O_2 + SO_2 (+ h\nu)$

Halstead and Thrush	NATUA-1964-204-992
Halstead and Thrush	CCOMA-1965-213
Halstead and Thrush	PHCBA-1965-4-1007
Halstead and Thrush	PRLAA-1966-295-380 (mechanism)
Homann, et al.	BBPCA-1969-73-967
McKenzie and Thrush	PRLAA-1968-308-133
Mettee, H. D.	JACSA-1968-90-2972
Olszyna and Heicklen	JPCHA-1970-74-4188 (mechanism)
Schofield, K.	PLSSA-1967-15-643
Thrush, B. A.	CHMBA-1966-2-287
Thrush, et al.	JPCHA-1968-72-3711

$O_3 + SO (+ M) \rightarrow O_2 + SO_2^* (+ M)$

Halstead and Thrush	CCOMA-1965-213
Halstead and Thrush	PHCBA-1965-4-1007
Halstead and Thrush	PRLAA-1966-295-380
Mettee, H. D.	JACSA-1968-90-2972
Schofield, K.	PLSSA-1967-15-643
Thrush, B. A.	CHMBA-1966-2-287
Thrush, et al.	JPCHA-1968-72-3711

$O_3 + SO_2 \rightarrow O_2 + SO_3$

Wilson and Levy	JPCAA-1970-20-385
Wilson, et al.	*APCPZ-1970-70-115 (mechanism)

$O_3 + SO_2 \rightarrow . . .$

Ripperton, et al.	ACSPA-1964-147-20.R

$R + SO_2 \rightarrow RSO_2$

Good and Thynne	TFSOA-1967-63-2708
Good and Thynne	TFSOA-1967-63-2720

$RH + SO_2^* \rightarrow RSO_2H$

Badcock, et al.	JACSA-1971-93-3115
Dainton and Ivin	TFSOA-1950-46-374
Sidebottom, et al.	JACSA-1971-93-3121
Timmons, R. B.	PHCBA-1970-12-219

$RSO_2 \rightarrow R + SO_2$

Good and Thynne	TFSOA-1967-63-2708
Good and Thynne	TFSOA-1967-63-2720

$S^* + M \rightarrow S + M$ (electronic relaxation)

Breckenridge, W. H., Jr.	DABBB-1969-30-1063
Breckenridge and Taube	JCPSA-1970-53-1750
Donovan, R. J.	TFSOA-1969-65-1419
Donovan, et al.	NATUA-1969-222-1164
Donovan, et al.	TFSOA-1970-66-774
Fair, et al.	CJCHA-1971-49-1659
Knight, et al.	JACSA-1963-85-2349
Knight, et al.	JACSA-1964-86-4243
Lown, et al.	JACSA-1967-89-1056
McGrath, et al.	CJCHA-1967-45-2454 (mechanism)

$S^* + M \rightarrow S + M^*$ (energy transfer)

Fowles, et al.	JACSA-1967-89-1352 (mechanism)
Gunning and Strausz	ADPCA-1966-4-143 (mechanism)
Sidhu, et al.	JACSA-1966-88-254

$S + M \rightarrow 1/8S_8 + M$

Breckenridge and Taube	JCPSA-1970-53-1750

$S^* + M \rightarrow 1/8S_8 + M$

Breckenridge and Taube	JCPSA-1970-53-1750

$S + S + M \rightarrow S_2 + M$

Bodenstein, M.	ZEPCA-1899-29-315 (mechanism)
Callear, A. B.	PRLAA-1963-276-401
Fowles, et al.	JACSA-1967-89-1352
Knight, et al.	JACSA-1963-85-1207 (mechanism)
Knight, et al.	JACSA-1963-85-2349 (mechanism)
Knight, et al.	JACSA-1964-86-4243 (mechanism)
Norrish and Rideal	JCSOA-1923-123-1689 (mechanism)
Porret, D.	HCACA-1936-19-680 (mechanism)
Porter, G.	DFSOA-1953-14-123 (mechanism)

$S + S + M \rightarrow S_2 + M^*$ (chemiexcitation)

Tewarson and Palmer	SYMCA-1971-13-99 (mechanism)

$S + S + M \rightarrow S_2^* + M$ (chemiexcitation)

Fair and Thrush	DFSOA-1967-44-236
Fair and Thrush	TFSOA-1969-65-1208
Tewarson and Palmer	SYMCA-1971-13-99 (mechanism)

$S + S_x \rightarrow yS_{(x+1)/y}$

Aynsley, et al.	JCSOA-1935-58 (mechanism)

$S + SH \rightarrow H + S_2$

Fair and Thrush	TFSOA-1969-65-1557
Mihelcic and Schindler	BBPCA-1970-74-1280

$S + SO_2 \rightarrow S_2O_2$

Jakovleva and Kondratjew	ACPYA-1940-13-241 (mechanism)
Kondratjew, V. N.	ACPYA-1942-16-272 (mechanism)

$SH + SH \rightarrow H + HS_2$

Fowles, et al.	JACSA-1967-89-1352 (mechanism)

$SH + SH \rightarrow H_2 + S_2$

Darwent, B. deB.	DFSØA-1953-14-123 (mechanism)
Darwent and Roberts	PRLAA-1953-216-344
Darwent, et al.	JPCHA-1967-71-2346 (mechanism)
Dzantiev and Shishkov	KHVKA-1967-1-192
Fair and Thrush	TFSØA-1969-65-1557
Fowles, et al.	JACSA-1967-89-1352
Gunning and Strausz	ADPCA-1966-4-143 (mechanism)
Mihelcic and Schindler	BBPCA-1970-74-1280
Norrish and Zeelenberg	PRLAA-1957-240-293 (related paper)
Perner and Franken	BBPCA-1969-73-897
Porter, G.	DFSØA-1953-14-123 (mechanism)
Stein, N. Ø.	TFSØA-1933-29-583 (mechanism)
Strausz, et al.	BBPCA-1968-72-253

$SH + SH \rightarrow H_2 + S_2^*$

Strausz, et al.	BBPCA-1968-72-253

$SH + SH \rightarrow H_2S + S$

Darwent, B. deB.	DFSØA-1953-14-123 (mechanism)
Darwent and Roberts	PRLAA-1953-216-344
Darwent, et al.	JPCHA-1967-71-2346 (mechanism)
Dzantiev and Shishkov	KHVKA-1967-1-192
Fair and Thrush	TFSØA-1969-65-1557
Forbes, et al.	JACSA-1938-60-1431 (mechanism)
Fowles, et al.	JACSA-1967-89-1352
Mihelcic and Schindler	BBPCA-1970-74-1280
Porter, G.	DFSØA-1953-14-123 (mechanism)
Strausz, et al.	BBPCA-1968-72-253

$SH + SH \rightarrow H_2S_2$

Forbes, et al.	JACSA-1938-60-1431 (mechanism)
Fowles, et al.	JACSA-1967-89-1352

$SH + SH \rightarrow H_2S_2^*$

Majerik, J. W.	DABBB-1970-31-555
Perner and Franken	BBPCA-1969-73-897 (calculation)

$S\emptyset + h\nu \rightarrow \emptyset + S$

Kornfeld and McCaig	TFSØA-1934-30-991 (mechanism)
Wieland, K.	TFSØA-1934-30-260 (mechanism)

$S\emptyset + M^* \rightarrow S\emptyset^* + M$ (energy transfer)

Breckenridge and Miller	ACSRA-1971-162-Phys. Chem. 87
Carrington, et al.	TFSØA-1966-62-2994

$S\emptyset^* + M \rightarrow S\emptyset + M^*$ (energy transfer)

Tewarson and Palmer	SYMCA-1971-13-99 (mechanism)

$S\emptyset + S\emptyset \rightarrow S + S\emptyset_2$

Donovan, et al.	TFSØA-1969-65-2930
Halstead and Thrush	PHCBA-1965-4-1007
Halstead and Thrush	PRLAA-1966-295-363
Hoyermann, et al.	BBPCA-1967-71-603
Sullivan and Warneck	BBPCA-1965-69-7
Tewarson and Palmer	SYMCA-1971-13-99 (mechanism)

$S\theta + S\theta \rightarrow S_2\theta_2$

Jakovleva and Kondratjew	ACPYA-1940-13-241 (mechanism)
Markovich and Emanuel	ZFKHA-1947-21-1251 (mechanism)
Norrish and Oldershaw	PRLAA-1959-249-498 (related paper)
Norrish and Zeelenberg	PRLAA-1957-240-293 (related paper)
Zeelenberg, A. P.	SYMCA-1959-7-68 (related paper)

$S\theta + S\theta_2 \rightarrow S + S\theta_3$

Bauer, et al.	SYMCA-1971-13-417 (mechanism)
Kornfeld and McCaig	TFSOA-1934-30-991 (mechanism)

$S\theta + S\theta_3 \rightarrow S\theta_2 + S\theta_2$

Halstead and Thrush	PHCBA-1965-4-1007
Norrish and Oldershaw	PRLAA-1959-249-498 (related paper)

$S\theta_2^* \rightarrow \theta + S\theta$

Driscoll and Warneck	JPCHA-1968-72-3736

$S\theta_2^* \rightarrow \theta_2 + S$

Driscoll and Warneck	JPCHA-1968-72-3736

$S\theta_2^* \rightarrow S\theta_2 + h\nu$

Badcock, et al.	JACSA-1971-93-3115
Bradley and Dobson	JCPSA-1967-47-1555
Caton and Duncan	JACSA-1968-90-1945
Collier, et al.	JACSA-1970-92-217
Douglas, A. E.	JCPSA-1966-45-1007
Fletcher and Levitt	TFSOA-1969-65-1544 (mechanism)
Gerlovin and Orlova	OPSUA-1964-16-9
Greenough and Duncan	JACSA-1961-83-555
Halstead and Thrush	PHCBA-1965-4-1007
Halstead and Thrush	PRLAA-1966-295-363 (mechanism)
Halstead and Thrush	PRLAA-1966-295-380
LeBreton, et al.	JCPSA-1971-55-2940
Levitt and Sheen	JCPSA-1964-41-584
Levitt and Sheen	TFSOA-1967-63-540
McKenzie and Thrush	PRLAA-1968-308-133
Mettee, H. D.	JACSA-1968-90-2972
Mettee, H. D.	JCPSA-1968-49-1784
Norrish and Zeelenberg	PRLAA-1957-240-293 (related paper)
Okuda, et al.	JPCHA-1969-73-4412 (mechanism)
Otsuka and Calvert	JACSA-1971-93-2581
Rao and Calvert	JPCHA-1970-74-681
Rao, et al.	JACSA-1969-91-1609
Rao, et al.	JACSA-1969-91-1616
Reeves and Emerson	JCPSA-1970-52-2161
Rolfes, et al.	JPCHA-1965-69-849 (mechanism)
Sidebottom, et al.	JACSA-1971-93-2587
Sidebottom, et al.	JACSA-1971-93-3121
Strickler and Howell	JCPSA-1968-49-1947
Thrush, B. A.	CHMBA-1966-2-287
Timmons, R. B.	PHCBA-1970-12-219 (mechanism)

$S\theta_2 + h\nu \rightarrow \theta + S\theta$

Driscoll and Warneck	JPCHA-1968-72-3736
Herman, et al.	JQSRA-1962-2-215 (mechanism)
Jakovleva and Kondratjew	ACPYA-1940-13-241
Kornfeld and McCaig	TFSOA-1934-30-991 (mechanism)
Norrish and Oldershaw	PRLAA-1959-249-498 (related paper)
Sullivan, et al.	NASCA-1961-N62-15918 (mechanism)
Wieland, K.	TFSOA-1934-30-260 (mechanism)

$SO_2 + h\nu \rightarrow SO_2^*$

Driscoll and Warneck	JPCHA-1968-72-3736
Sullivan, et al.	NASCA-1961-N62-15918 (mechanism)

$SO_2 + M \rightarrow O + SO + M$

Keck and Kalelkar	*AVEVZ-1968-289 (calculation)
Levitt and Sheen	TFSOA-1967-63-2955
Olschewski, et al.	ZPCFA-1965-44-173
Troe and Wagner	BBPCA-1967-71-937

$SO_2^* + M \rightarrow O + SO + M$

Levitt and Sheen	TFSOA-1967-63-540

$SO_2 + M \rightarrow SO_2^* + M$ (electronic excitation)

Gaydon, et al.	PRLAA-1963-276-461
LeBreton, et al.	JCPSA-1971-55-2940

$SO_2 + M^* \rightarrow SO_2 + M$ (electronic relaxation)

Badcock, et al.	JACSA-1971-93-3115
O'Brien and Myers	JCPSA-1970-53-3832

$SO_2 + M^* \rightarrow SO_2^* + M$ (energy transfer)

Tewarson and Palmer	SYMCA-1971-13-99 (mechanism)

$SO_2^* + M \rightarrow SO_2 + M$ (electronic relaxation)

Badcock, et al.	JACSA-1971-93-3115
Collier, et al.	JACSA-1970-92-217
Dainton and Ivin	TFSOA-1950-46-374
Dainton and Ivin	TFSOA-1950-46-382
Driscoll and Warneck	JPCHA-1968-72-3736
Fletcher and Levitt	TFSOA-1969-65-1544 (mechanism)
Greenough and Duncan	JACSA-1961-83-555
Halstead and Thrush	PHCBA-1965-4-1007
Halstead and Thrush	PRLAA-1966-295-363 (mechanism)
Halstead and Thrush	PRLAA-1966-295-380
Jackson and Calvert	JACSA-1971-93-2593
Levitt and Sheen	JCPSA-1964-41-584
Levitt and Sheen	TFSOA-1967-63-540
McKenzie and Thrush	PRLAA-1968-308-133
Mettee, H. D.	JCPSA-1968-49-1784
Mettee, H. D.	JPCHA-1969-73-1071
Okuda, et al.	JPCHA-1969-73-4412
Olschewski, et al.	ZPCFA-1965-44-173
Otsuka and Calvert	JACSA-1971-93-2581
Rao and Calvert	JPCHA-1970-74-681
Rao, et al.	JACSA-1969-91-1609
Rao, et al.	JACSA-1969-91-1616
Rolfes, et al.	JPCHA-1965-69-849 (mechanism)
Shirai, et al.	KGKZA-1962-65-1906 (mechanism)
Sidebottom, et al.	JACSA-1971-93-2587
Sidebottom, et al.	JACSA-1971-93-3121
Strickler and Howell	JCPSA-1968-49-1947
Thrush, B. A.	CHMBA-1966-2-287
Timmons, R. B.	PHCBA-1970-12-219

$SO_2^* + M \rightarrow SO_2 + M$ (vibrational relaxation)

Bass, et al.	JCPSA-1971-54-644
Bauer, et al.	SYMCA-1971-13-417
Cottrell and McCoubrey	BOOKA-1961-97 (review)

SO_2^* + M → SO_2 + M (vibrational relaxation) (Continued)

Dickens and Linnett	PRLAA-1957-243-84 (calculation)
Fricke, E. F.	JASMA-1940-12-245
Grossmann, E.	ANPYA-1932-13-681
Herzfeld and Litovitz	BOOKA-1959-253 (review)
Kneser, H. O.	ANPYA-1933-16-337
Lambert and Salter	PRLAA-1958-243-78
McCoubrey, et al.	PRLAA-1961-264-299
Petralia, S.	NUCIA-1952-9-818
Richards and Reid	JCPSA-1934-2-193
Schweikert, G.	ANPYA-1915-48-593
Shields, F. D.	JCPSA-1967-46-1063
Shields and Anderson	JCPSA-1971-55-2636

SO_2^* + M → SO_2 + M^* (energy transfer)

Levitt and Sheen	TFSOA-1965-61-2404
Rao, et al.	JACSA-1969-91-1609
Sidebottom, et al.	JACSA-1971-93-2587

SO_2 + SO_2^* → SO + SO_3

Badcock, et al.	JACSA-1971-93-3115
Driscoll and Warneck	JPCHA-1968-72-3736
Gaydon, et al.	PRLAA-1963-276-461
Jackson and Calvert	JACSA-1971-93-2593
Jakovleva and Kondratjew	ACPYA-1940-13-241
Okuda, et al.	JPCHA-1969-73-4412
Olschewski, et al.	ZPCFA-1965-44-173
Otsuka and Calvert	JACSA-1971-93-2581
Sidebottom, et al.	JACSA-1971-93-2587
Sullivan, et al.	NASCA-1961-N62-15918 (mechanism)

SO_2 + SO_4 → SO_3 + SO_3

Shirai, et al.	KGKZA-1962-65-1906 (mechanism)

SO_3 + hν → O + SO_2

Norrish and Oldershaw	PRLAA-1959-249-498 (related paper)

SO_3 + hν → O_2 + SO

Norrish and Oldershaw	PRLAA-1959-249-498

SO_3 + hν → $1/2O_2$ + SO_2

Coehn, A.	ZEELA-1907-13-545
Coehn and Becker	ZEPCA-1910-70-88

SO_3 + M → O + SO_2 + M

Nettleton and Stirling	SYMCA-1969-12-635

SO_3^* (+ M) → O + SO_2 (+ M)

Jaffe and Klein	TFSOA-1966-62-2150

SO_3 + M → O_2 + SO + M

Gaydon, et al.	PRLAA-1963-276-461 (mechanism)

SO_3 + M → $1/2O_2$ + SO_2 + M

Hedley, A. B.	FUSJA-1962-13-45
Hedley, A. B.	*PICFZ-1963-204
Levy and Merryman	JEPOA-1965-87-116
Vitukhnovskaya and Belyanskaya	JAPUA-1960-33-2397

$S\emptyset_3^* + M \rightarrow S\emptyset_3 + M$ (electronic relaxation)

Jaffe and Klein	TFSØA-1966-62-2150
Tipper and Williams	TFSØA-1960-56-1805 (mechanism)

$S\emptyset_4 \rightarrow \emptyset_2 + S\emptyset_2^*$

Katz and Gale	*IUAPZ-1970-CP-1E

$nS_2 \rightarrow S_{2n}$

Bodenstein, M.	ZEPCA-1899-29-315 (mechanism)
Breckenridge and Taube	JCPSA-1970-53-1750
Gunning and Strausz	ADPCA-1966-4-143 (mechanism)
Knight, et al.	JACSA-1963-85-1207 (mechanism)
Knight, et al.	JACSA-1963-85-2349 (mechanism)
Knight, et al.	JACSA-1964-86-4243 (mechanism)
Porret, D.	HCACA-1936-19-680 (mechanism)
Porter, G.	PRLAA-1950-200-284
Strausz and Gunning	JACSA-1962-84-4080
Wright, F. J.	JPCHA-1960-64-1648

$S_2^* \rightarrow S_2 + h\nu$

Durand, E.	JCPSA-1940-8-46
Fair and Thrush	DFSØA-1967-44-236
Fair and Thrush	TFSØA-1969-65-1208

$S_2 + M \rightarrow S + S + M$

Bodenstein, M.	ZEPCA-1899-29-315 (mechanism)
Norrish and Rideal	JCSØA-1923-123-1689 (mechanism)

$S_2^* + M \rightarrow S_2 + M$ (electronic relaxation)

Basco and Pearson	TFSØA-1967-63-2684
Donovan, et al.	NATUA-1969-222-1164
Fair and Thrush	DFSØA-1967-44-236
Fair and Thrush	TFSØA-1969-65-1208

$S_2^* + M \rightarrow S_2 + M$ (vibrational relaxation)

Durand, E.	JCPSA-1940-8-46

$S_2^* + M \rightarrow S_2 + M^*$ (energy transfer)

Fowles, et al.	JACSA-1967-89-1352
Tewarson and Palmer	SYMCA-1971-13-99 (mechanism)

$S_2 + S_2 + M \rightarrow S_4 + M$

Callear, A. B.	PRLAA-1963-276-401
Fowles, et al.	JACSA-1967-89-1352
Majerik, J. W.	DABBB-1970-31-555
Norrish and Rideal	JCSØA-1923-123-1689 (mechanism)
Norrish and Rideal	JCSØA-1923-123-3202 (mechanism)

$S_2\emptyset_2 \rightarrow S + S\emptyset_2$

Myerson, et al.	JCPSA-1957-26-1309 (mechanism)

$S_2\emptyset_2 + h\nu \rightarrow S\emptyset + S\emptyset$

Zeelenberg, A. P.	SYMCA-1959-7-68 (related paper)

$S_4 + M \rightarrow S_2 + S_2 + M$

Norrish and Rideal JCSØA-1923-123-1689 (mechanism)
Norrish and Rideal JCSØA-1923-123-3202 (mechanism)

$S_4 + S_4 + M \rightarrow S_8 + M$

Norrish and Rideal JCSØA-1923-123-1689 (mechanism)
Norrish and Rideal JCSØA-1923-123-3202 (mechanism)

$S_8 + M \rightarrow S_4 + S_4 + M$

Norrish and Rideal JCSØA-1923-123-1689 (mechanism)
Norrish and Rideal JCSØA-1923-123-3202 (mechanism)

III(b). REVIEWS

Bufalini, M. ESTHA-1971-5-685

Cottrell and McCoubrey BØØKA-1961-97

Gunning and Strausz ADPCA-1966-4-143

Herzfeld and Litovitz BØØKA-1959-253

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16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

A bibliography, a reaction oriented list of references, is provided for published papers and reports containing rate data for reactions of COS, COS_2, CS, CS_2, CS_3, D_2S, H_2S, H_2S_2, HSO_2, S, SH, SO, SO_2, SO_3, SO_4, S_2, S_2O_2, S_4, S_6 and S_8 with each other and with CO, CO_2, D, D_2, H, H_2, H_2O, N, N_2, N_2O, N_2O_5, NO, NO_2, NO_3, NOS, O, OH, O_2, O_3, R and RH. Three lists of critical reviews dealing with the above reactions are included. 317 papers covering 240 reactions are listed. The period covered extends from 1899 through June 1971.

17. KEY WORDS (Alphabetical order, separated by semicolons)
Bibliography; carbon oxysulfides; carbon sulfides; chemical kinetics; gas phase; hydrogen; nitrogen; nitrogen oxides; oxygen; sulfur; sulfur hydrides; sulfur oxides.

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